CaloTower Response from the Measured Jet Energy Response

Robert Harris, Konstantinos Kousouris
Fermilab

HCAL Calibration meeting
18/06/2009

Outline

- ➡ Motivation & Goal
- ➡ CaloTower relative response
- ➡ Closure
- ➡ Residual HCAL response
- ➡ Proof of principle

Motivation & Goal

☑ **We present a method to measure the CaloTower response.**

☑ **Takes advantage of the already measured relative jet energy correction (L2) with the established dijet balance method.**

- We will have this measurement anyway and we should see what it implies for the CaloTower response.

☑ **Options for use:**

- Cross-check of the existing method for CaloTower calibration.
- Or it can be used to monitor changes with time in the HCAL response.
- Can be used to calibrate the CaloTowers in such a way that the reconstructed jets of fixed p_T have uniform response vs η. However, flattening the response at low p_T will introduce variations at higher p_T.

☑ **The present study is only a demonstration of the method.**

From Jets to CaloTowers

The jet energy is corrected with the relative correction which makes the response uniform in η. The technique is well established and approved by CMS (PAS-CMS-JME-08-003).

$$E_{jet}^{cor} = L2(p_T^{jet}, \eta^{jet}) \cdot E_{jet}$$

From the relative jet correction we can infer a CaloTower correction which reproduces the corrected energy of fixed p_T jets. This is done by a simple χ^2 minimization procedure. The resulting correction is the same for all CaloTowers in the same η ring.

$$E_{jet}^{cor} = \sum c_{tow} E_{tow}$$

χ^2 Minimization

$$\chi^2 = \sum_i \left(E_i^{jet} - \sum_k c_k^{tow} E_{k,i}^{tow} \right)^2$$

Sum over the jet sample

$$\frac{\partial \chi^2}{\partial c_k^{tow}} = 0$$

82 minimization conditions
(one per CaloTower ring)

$$\sum_k c_k^{tow} B_{kl} = \Gamma_l$$

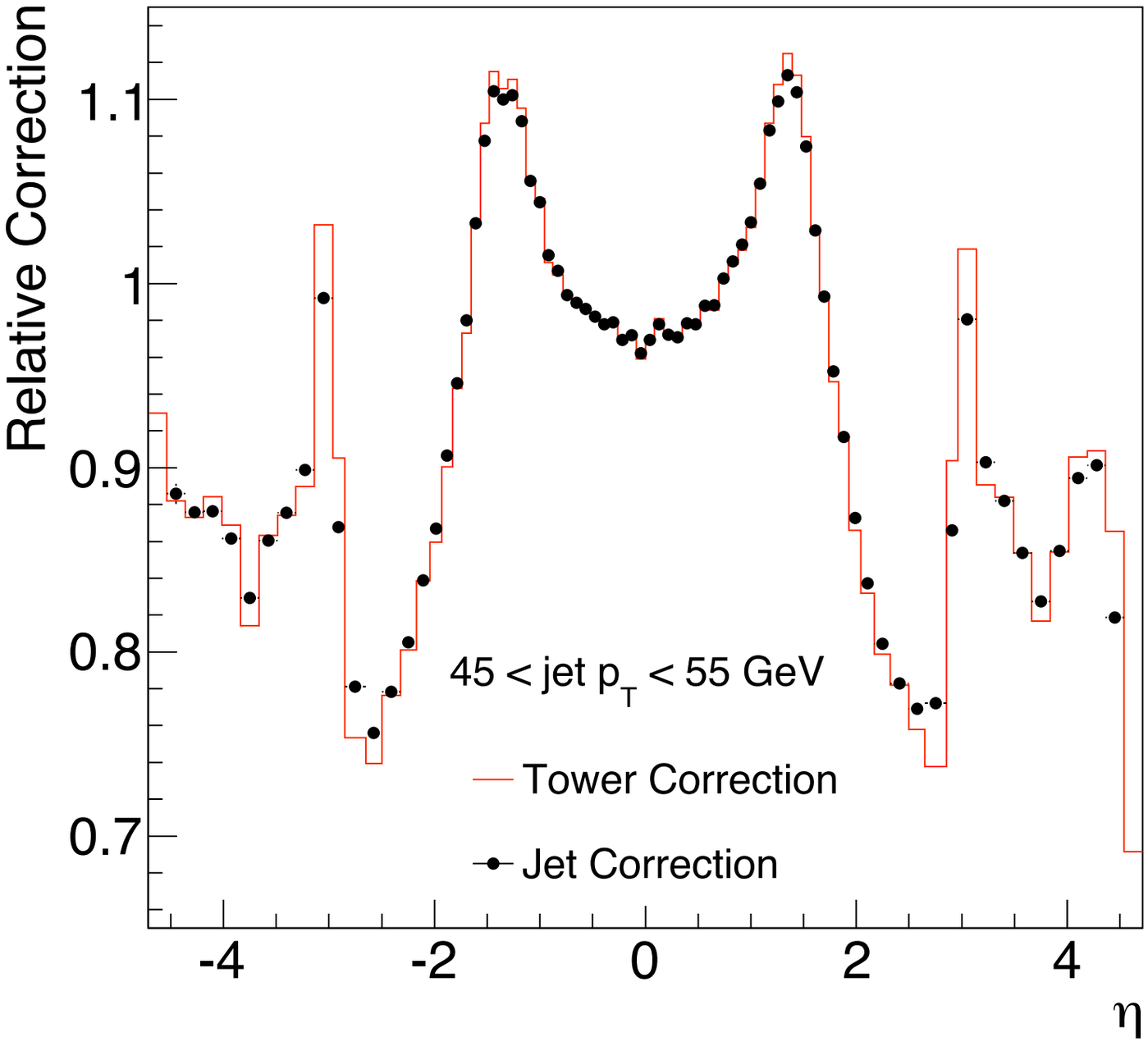
82 coupled linear equations

$$B_{kl} = \langle E_k^{tow} E_l^{tow} \rangle$$

$$\Gamma_l = \langle E^{jet} E_l^{tow} \rangle$$

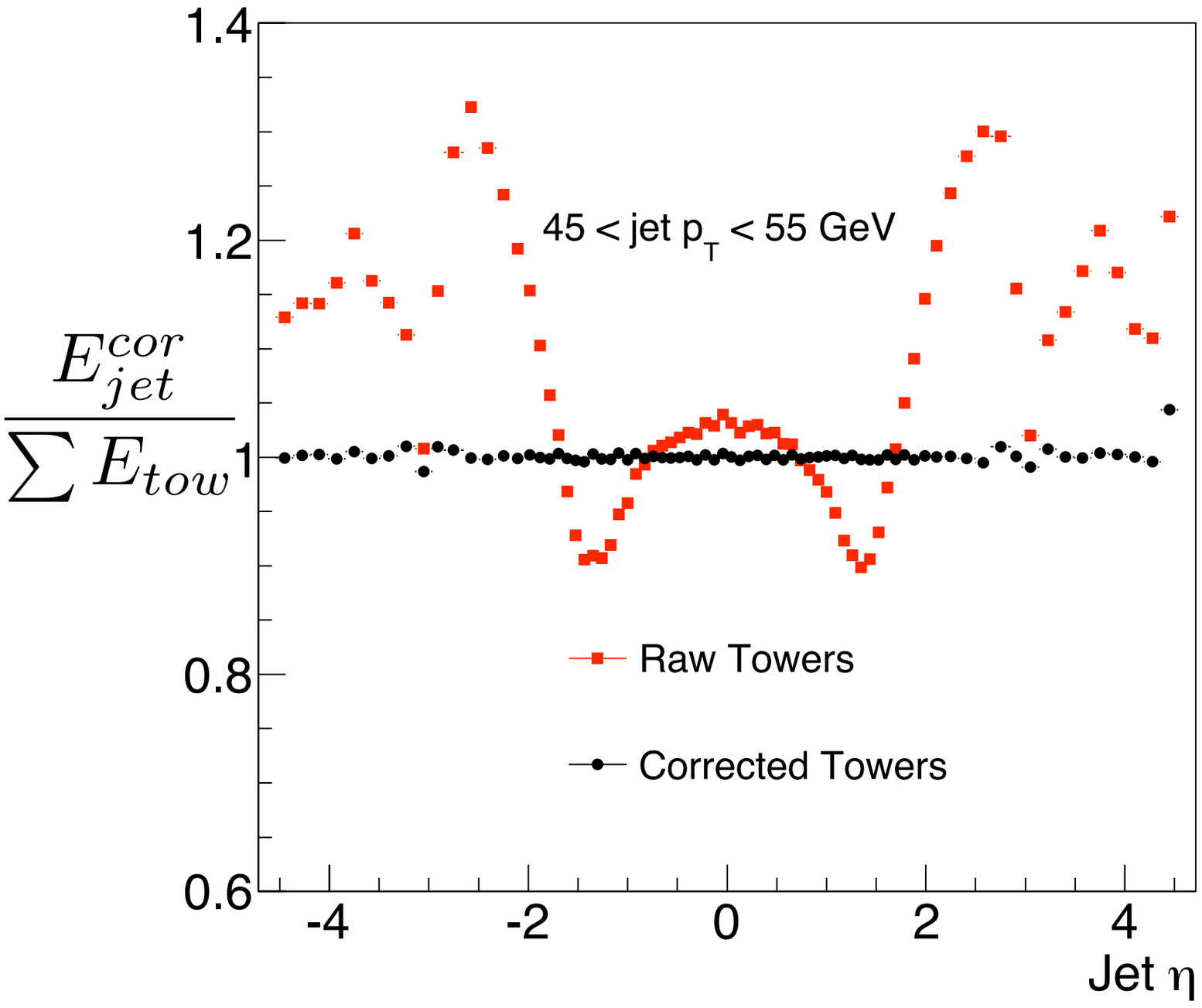
Mean values over
the jet sample

CaloTower Correction



- Demonstration using the MC truth relative jet correction in 82 η bins. The measurement with early data will be ~ 4 times coarser.
- The CaloTower correction is a measure of 1/Response.
- The CaloTower correction is sharper than the jet correction.
- The finer the jet correction in η, the closer it is to the CaloTower correction.

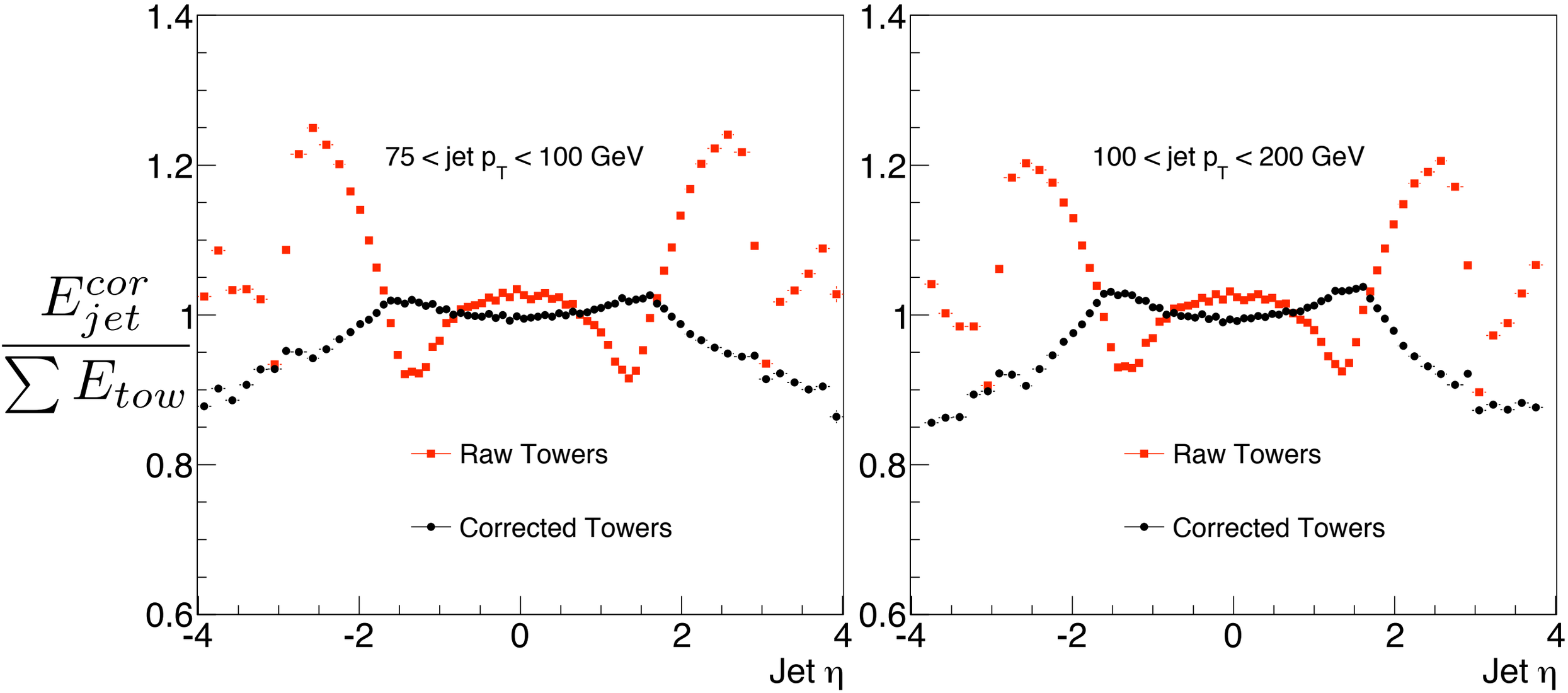
Does the CaloTower Correction work?



☑ The sum of the energies of all the corrected CaloTower constituents equals the corrected jet energy on average.

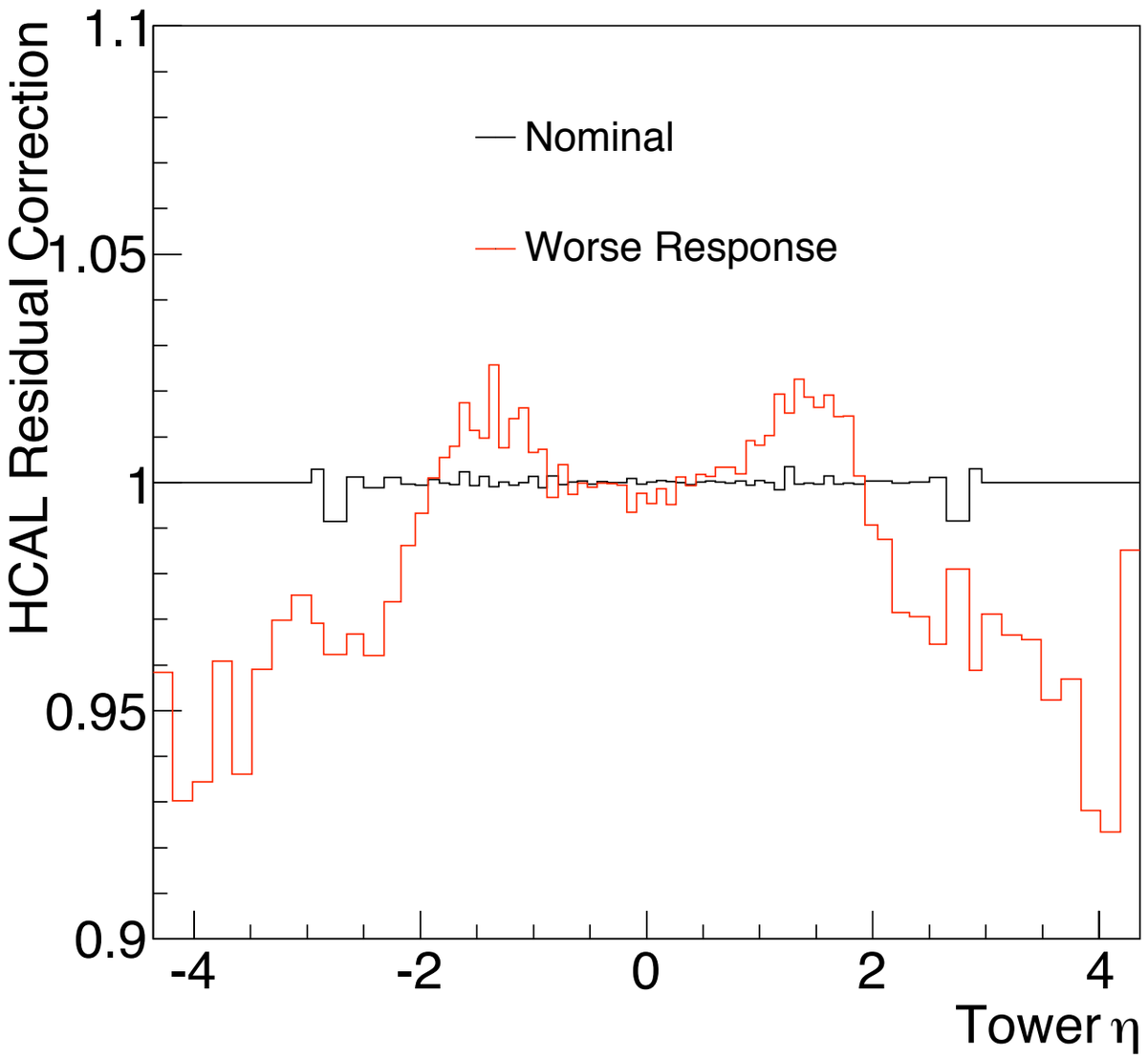
☑ The correction works only for $p_T \sim 50$ GeV jets.

CaloTower Correction at Higher Jet p_T



A CaloTower correction derived at low energy, has a large impact on the response of the higher p_T jets. Do we really want to apply a constant correction that flattens the response at some fixed p_T (or energy) value?

Monitoring of the HCAL Response



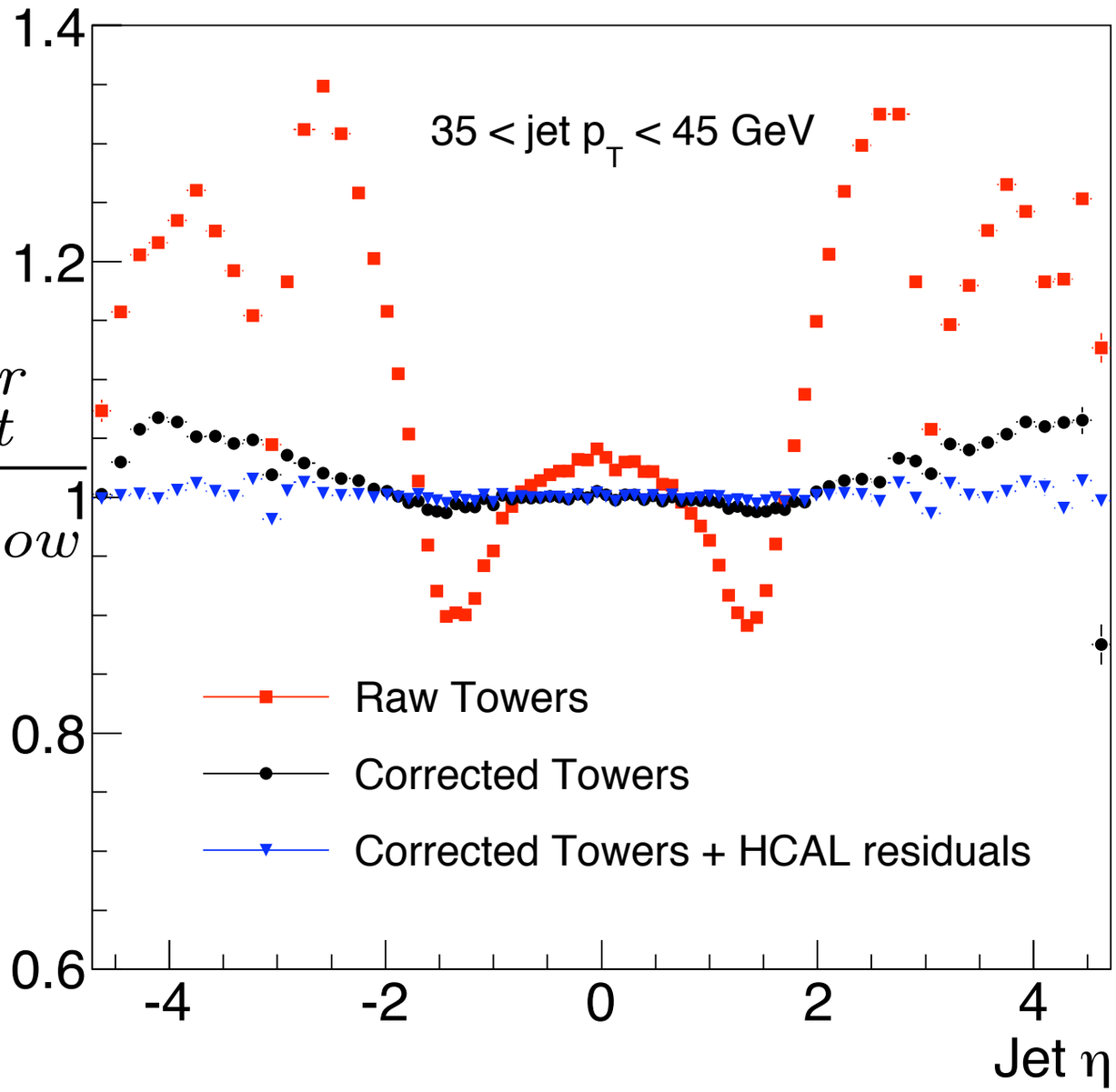
- The residual HCAL correction is derived on top of a "nominal" CaloTower correction, with a X^2 minimization procedure.
- Basic assumption: the ECAL response is stable.
- It can be used to monitor the changes in HCAL response.

Residual correction attributed to changes in HCAL response

$$E_{jet}^{cor} = \sum c_{tow} \left(E_{tow}^{ECAL} + \beta_{tow} E_{tow}^{HCAL} \right)$$

Nominal CaloTower correction derived at some point in time (treated as constant in the χ^2 minimization).

Proof of Principle



✦ We assume that the "nominal" correction is the one corresponding to p_T = 50 GeV jets.

✦ The nominal correction is applied to the CaloTower constituents of p_T = 40 GeV jets (worse response) and it fails to reproduce the corrected jet energy.

✦ After applying to the CaloTowers the residual HCAL correction, the corrected jet energy is fully recovered.

Summary

1) We have presented a method to measure the CaloTower response. This is defined as a set of constants that multiply the energy of each CaloTower in order to reconstruct jets with uniform response in η for fixed jet p_T.

2) The method relies on the prior knowledge of the relative jet energy correction which will be measured and understood through the dijet balance technique.

3) Applying a constant CaloTower correction, designed to flatten the response in η for some fixed p_T or energy, will have a large impact on higher p_T jets.

4) With specific assumptions (ECAL stability), the inferred CaloTower response can be used to monitor changes in the HCAL response and correct for them.

5) The material presented here serves only as an introduction to the method. A more realistic study should be pursued.